

LA-UR-18-27513

Approved for public release; distribution is unlimited.

Title: Genetic Algorithm Based Critical Experiment Design for Uranium Cross Section Validation

Author(s): Fritz, Dominik Arthur

Intended for: Keepin nonproliferation summer program

Issued: 2018-08-07

Disclaimer:

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by the Los Alamos National Security, LLC for the National Nuclear Security Administration of the U.S. Department of Energy under contract DE-AC52-06NA25396. By approving this article, the publisher recognizes that the U.S. Government retains nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.

Genetic Algorithm Based Critical Experiment Design for Uranium Cross Section Validation

Dominik Fritz^{1,2}

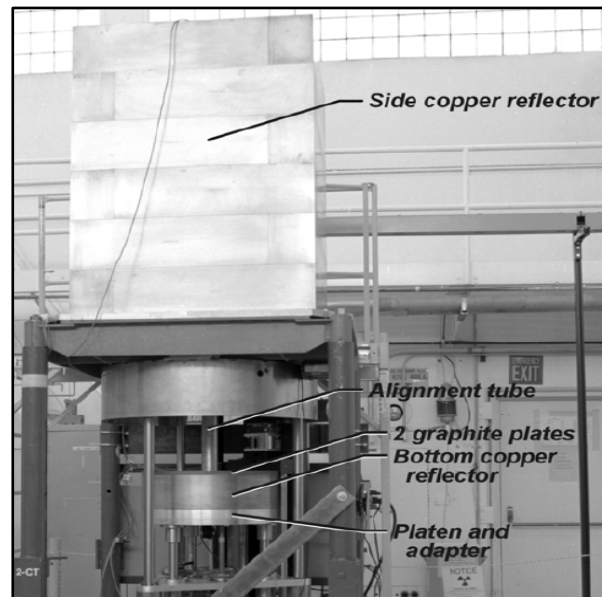
Mentors: Theresa Cutler¹, Rian Bahran¹, Jesson Hutchinson¹

¹**Los Alamos National Laboratory**

NEN-2 Advanced Nuclear Technology



²**Rensselaer Polytechnic Institute**



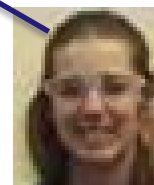
LA-UR-18-XXXX

Abiquiu Cliff Jumping



Dominik Fritz

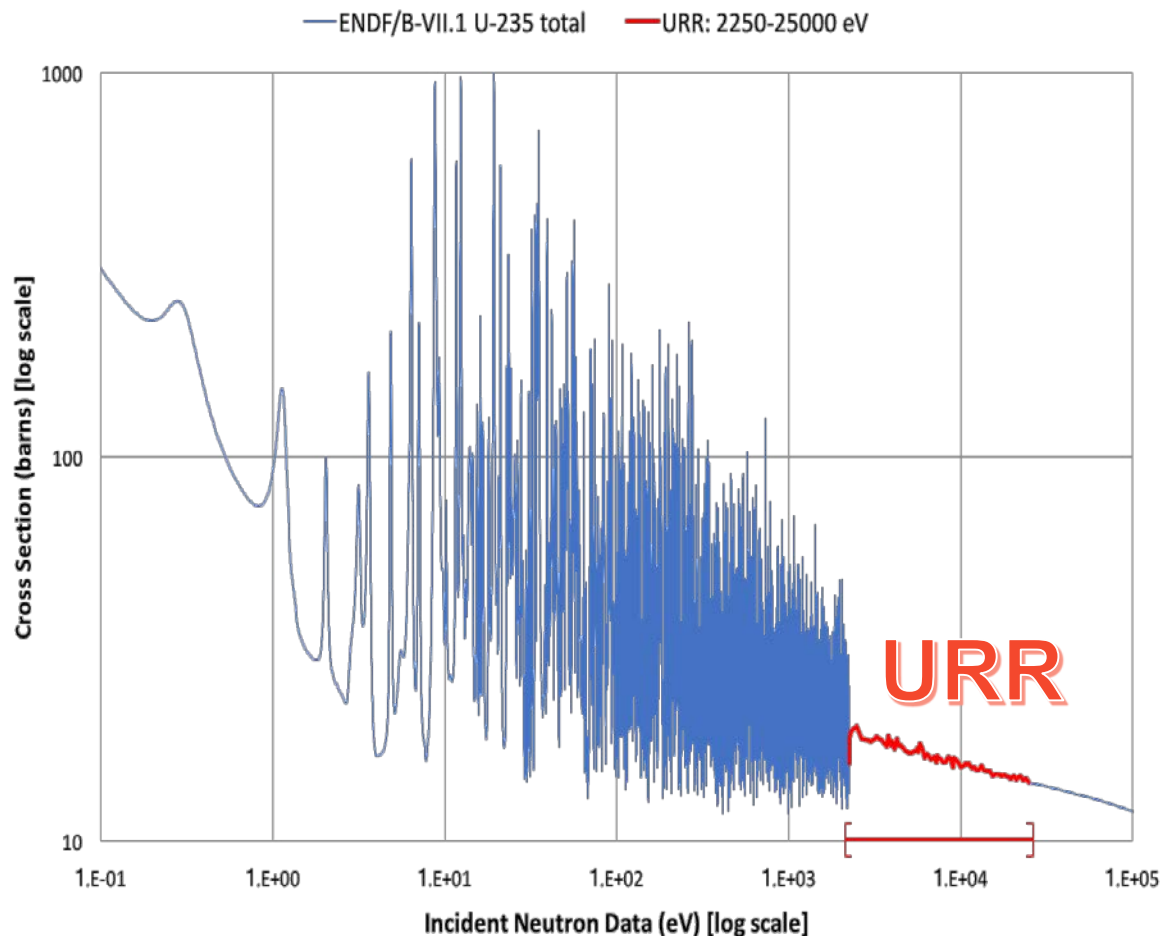
- Educational Background
 - BS Nuclear Engineering - RPI, Dec. 2018
 - Ph.D. Nuclear Science and Engineering - RPI, 2018
- Group
 - NEN-2 Advanced Nuclear Technology
 - Theresa Cutler, Rian Bahran, Jesson Hutchinson
- Research
 - Critical Experiment Design



U.S.
Nuclear
Triad

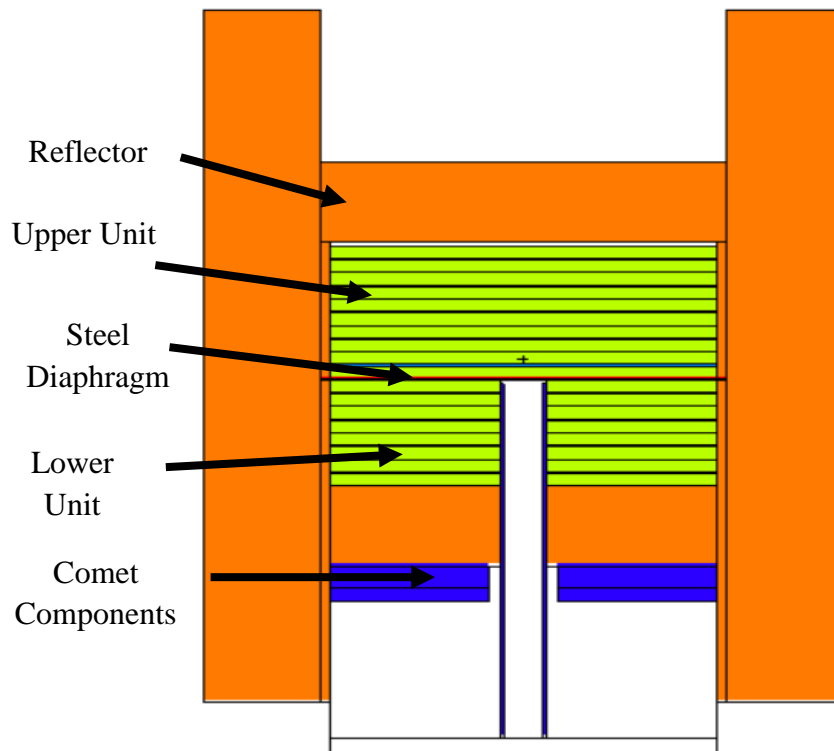
Research Overview and Motivation

- **Purpose** – Validate new differential U-235 fission cross-section measurements in the Unresolved Resonance Region (URR)
- **Motivation**
 - Modeling and simulation depend on the accuracy of underlying differential nuclear data
 - U-235 fission cross section validation enhances the safety of all uranium based nuclear systems



Research Approach

- The primary method of nuclear data validation is the use of critical experiments
- A genetic algorithm was employed to optimize the design of the critical experiment on the largest fraction of fission sensitivity occurring in the URR using MCNP® 6.1.1.



Vertical cross section of the optimized
Teflon moderated critical assembly

Summary of Results

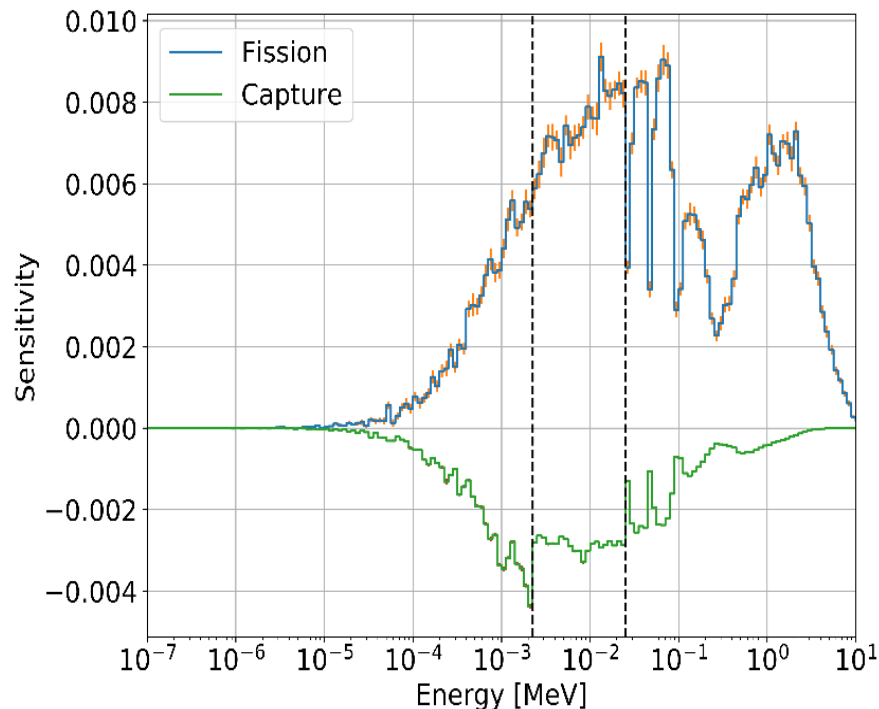
Optimized Moderator Material Comparisons

Material	Lucite	BeO	Be	HMI006-3	Graphite	Alumina	Teflon
Thickness [cm]	0.466	1.677	1.135	2.015	1.640	2.011	2.276
URR Fission Sensitivity Fraction	0.1027	0.2027	0.2096	0.2173	0.2202	0.2844	0.3087
URR Capture Sensitivity Fraction	0.0452	0.1007	0.0837	0.0906	0.0912	0.1074	0.1178
URR Fission Sensitivity Integral	0.4051	0.4143	0.4794	0.4889	0.4973	0.5104	0.4967
URR Capture Sensitivity Integral	0.1829	0.1980	0.1689	0.1550	0.1458	0.1418	0.1575
Fission Integral to Capture Integral	2.21	2.09	2.84	3.15	3.41	3.60	3.15
	Poor			Ok	Good	Better	Great

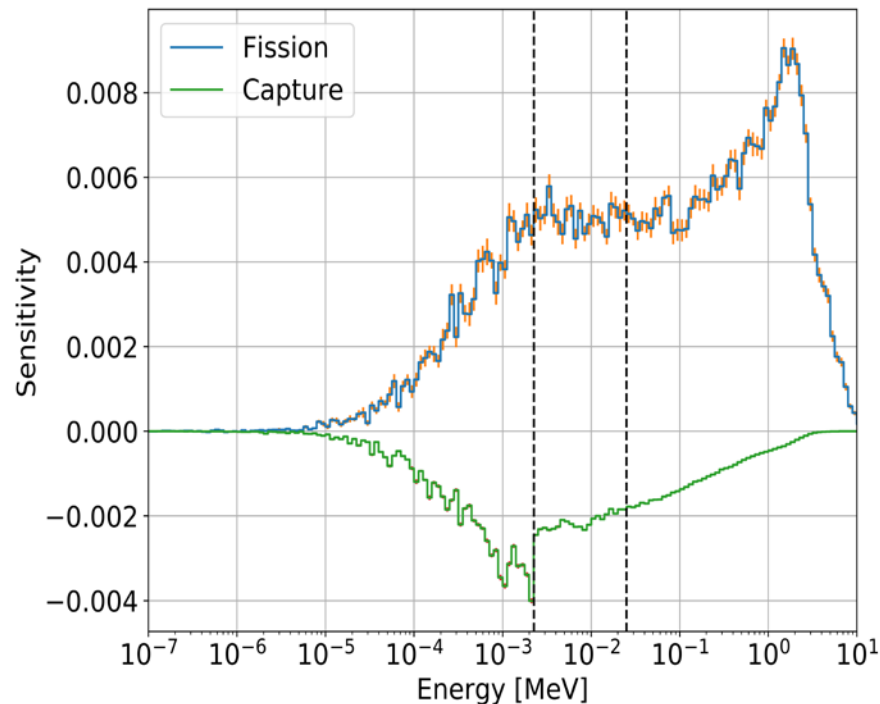
- URR Fission Sensitivity Fraction = Optimized Parameter, therefore Teflon is optimal material

Sensitivity Profiles – Teflon vs. HMI006-3

Optimized Teflon Sensitivity Profile



HMI006-3 Sensitivity Profile



- Teflon has a significantly higher fraction of fission sensitivity in the URR than HMI006-3